

A NEW SPECIES OF *COELOSTATHMA* CLEMENS (LEPIDOPTERA:
TORTRICIDAE) FROM COCOS ISLAND, COSTA RICA, WITH COMMENTS
ON THE PHYLOGENETIC SIGNIFICANCE OF ABDOMINAL DORSAL
PITS IN SPARGANOTHINI

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Abstract.—The entomofauna of Cocos Island, Costa Rica, includes nearly 100 species of Lepidoptera, among which are 13 species of Tortricidae, most of which are endemic. One of these, *Coelostathma insularis*, new species, is described and illustrated. The new species is most similar to *C. binotata* (Walsingham) from Mexico among described species. The genus *Coelostathma* Clemens is redescribed, and a lectotype is designated for *C. binotata*. The shared possession of abdominal dorsal pits in *Coelostathma* Clemens, *Amorbia* Clemens, and *Aesicopa* Zeller suggests a close phylogenetic relationship among these genera within Sparganothini; the variably modified subdorsal pits in *Sparganopseustis* Powell and Lambert may or may not be homologous with those of the other genera.

Key Words: Neotropical, endemic species, *Coelostathma insularis*, *Amorbia*, Archipini, Euliini

Cocos Island is a small volcanic island located in the tropical eastern Pacific, approximately midway between mainland Costa Rica and the Galapagos Archipelago (i.e., ca. 500 km offshore). Its rugged topography and isolation from the mainland have combined to inhibit permanent settlement by humans; consequently, much of the native biota is relatively undisturbed. In 1979 the Costa Rican government designated the island a nature reserve.

The entomofauna of Cocos Island was the subject of an investigation by Hogue and Miller (1981) who cited approximately 75 species of Lepidoptera from the island. Through continued published (e.g., Brown

et al. 1991, Brown 1991) and unpublished taxonomic studies, the number of species of Lepidoptera documented from the island has risen to nearly 100. The Tortricidae is well represented on Cocos Island, constituting 13 species (ca. 13% of the fauna), most of which appear to be endemic and undescribed. In this paper we describe one of these as new; two others will be described in a recently completed revision of *Sparganothina* Powell (Landry and Powell 1999). We also comment on the distribution of abdominal dorsal pits within Sparganothini and speculate on the value of these structures as a character for inferring phylogenetic relationships within the tribe.

MATERIALS AND METHODS

Specimens from Cocos Island were borrowed from the Natural History Museum of Los Angeles County (LACM), Los Angeles, California; Museum of Comparative Zoology (MCZ), Harvard University, Cambridge, Massachusetts; California Academy of Sciences (CAS), San Francisco, California; and other collections noted in Hogue and Miller (1981). Comparative material was examined at the Essig Museum of Entomology (UCB), University of California, Berkeley; Instituto Nacional de Biodiversidad (INBio), Santo Domingo de Heredia, Costa Rica; National Museum of Natural History (USNM), Smithsonian Institution, Washington, D.C.; and The Natural History Museum (BMNH), London, England. Dissection methodology follows that summarized in Brown and Powell (1991). Forewing measurements were made with an ocular micrometer mounted in a dissecting microscope. Terminology for wing venation and genitalic structures follows Horak (1984). Abbreviations and symbols are as follows: FW = forewing; HW = hindwing; n = number examined; ca. = circa (approximately); \bar{x} = mean.

SYSTEMATICS

Coelostathma Clemens 1860

Type species.—*Coelostathma discopunctana* Clemens 1860, by original designation.

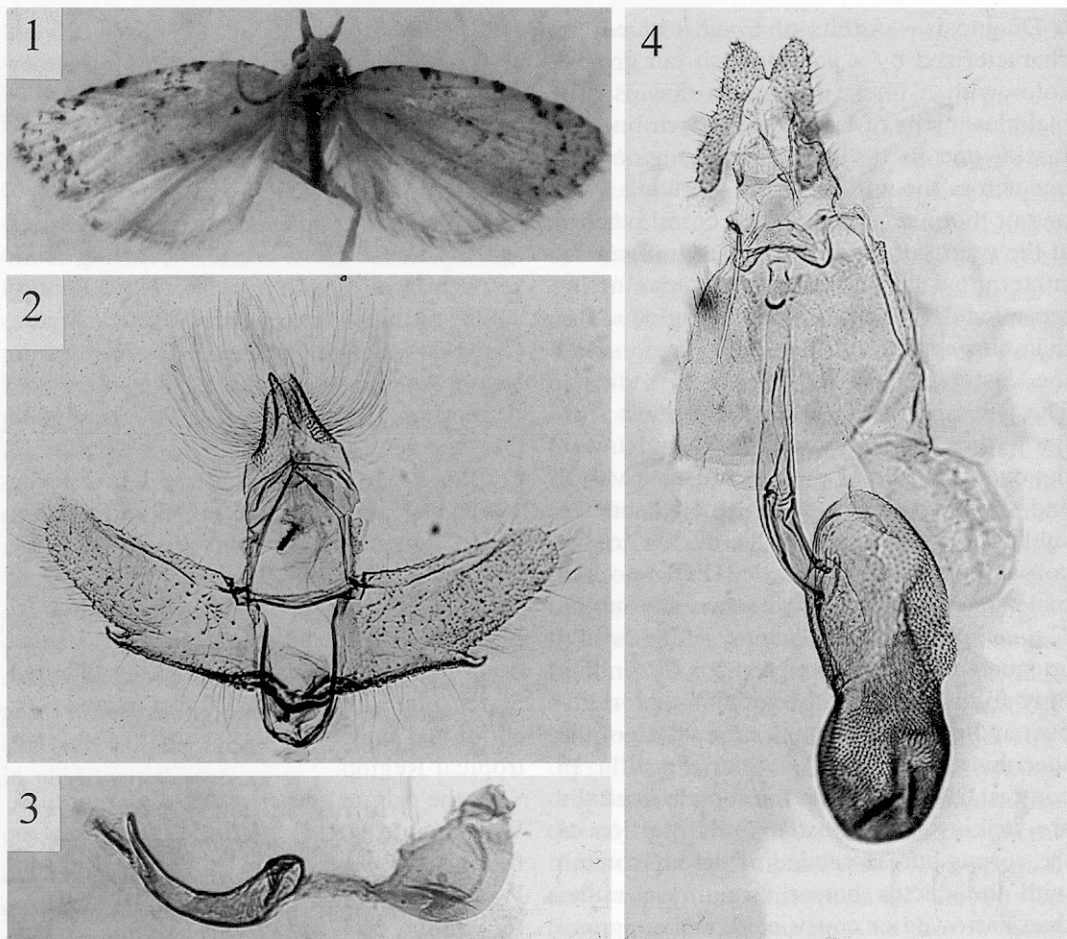
Redescription.—**Head:** Antennal scaling in two bands per segment, cilia ca. 1.75–2.25 times flagellomere width in male, short, unmodified in female; ocelli moderate to large; chaetosema present; labial palpus moderately long, upturned, II segment ca. 1.5 times horizontal diameter of compound eye, slightly expanded distally by scaling; III segment 0.2–0.3 as long as II, smooth-scaled, exposed; maxillary palpus rudimentary; proboscis well developed. **Thorax:** Legs unmodified. Forewing length 6–11 mm; apex falcate; costal fold absent in male; upraised scales absent; R_2 and R_3

short-stalked; R_4 and R_5 long-stalked (from $R_2 + R_3$ base). Hindwing with cubital hair pecten well developed in both sexes; no anal fold or hairpencil. **Abdomen:** Usually with a single middorsal pit at anterior edge of A2 (infrequently on other segments as well); female lacking enlarged corethrogynous scaling. Male genitalia with uncus simple, usually slender; socius large, flat, kidney bean-shaped; gnathos absent; transtilla a simple, narrow, spiny band; valva short, somewhat rounded, with attenuate apex; sacculus usually slender, well defined. Aedeagus curved; vesica with patch of slender cornuti. Female genitalia with weakly bilobed sterigma; ductus bursae moderately long, slender, well differentiated from corpus; corpus bursae oblong; signum long, nearly straight (rarely absent). **Sexual dimorphism:** Slight, restricted to subtle differences in color pattern, forewing length (females average slight larger in some species), and antennal cilia length (longer in males).

Coelostathma insularis J. Brown and S. Miller, new species

(Figs. 1–4)

Male.—**Head:** Frons smooth-scaled, white; vertex with overhanging crown of pale tan scales. **Thorax:** Smooth-scaled, pale tan. Forewing (Fig. 1): Length 6.5 mm (n = 1). Pale yellow tan, with pattern elements reduced, comprised of series of small brown dots of variable size, distributed along costa and subterminal region; irregular dotted line from costa ca. 0.75 distance from base to apex, roughly paralleling termen, intersecting dorsum in tornal region. Costal fold absent. Fringe pale yellow tan. Hindwing: Slightly darker than FW ground color; markings absent. Fringe concolorous with HW. **Abdomen:** Single medial dorsal pit on each segment A2–A7. **Genitalia** (Figs. 2, 3): Uncus moderately short, stout, attenuate distally, projecting only slightly beyond dorsal lobe of socius. Socius large, densely scaled, attached subbasally, without



Figs. 1-4. *Coelostathma insularis*. 1, Adult male. 2, Male genitalia, valvae spread. 3, Aedeagus. 4, Female genitalia.

secondary free arms. Transtilla a uniform narrow band, finely spined dorsally. Valva moderately broad, rounded apically; costa differentiated; sacculus well defined, extending ca. 0.6 distance from base to apex, ending in a short, free, curved, pointed tip. Aedeagus (Fig. 3) simple, evenly curved throughout; phallobase simple, rounded; vesica with a bundle of 4-5 slender cornuti.

Female.—FW length 6.5-6.8 mm (\bar{x} = 6.7; n = 2). Essentially the same as male, except antennal cilia ca. 0.1 times width of flagellomere and abdomen with a single medial dorsal pit on A2. *Genitalia* (Fig. 4): Papillae anales simple, slender. Sterigma a lightly sclerotized band with elbowed ven-

tral corners; ring of sclerotization around ostium. Ductus bursae moderately narrow, differentiated from corpus; antrum conspicuous; frail bursa seminalis arising from narrow ductus near antrum. Corpus bursae oblong, densely spiculate; signum absent. Ductus bursae joining corpus subbasally, i.e., approximately 0.7 distance from anterior end.

Types.—*Holotype* ♂: COSTA RICA, Cocos Island, Wafer Bay, 17/22 April 1975, C. L. Hogue (LACM). *Paratypes*: Same data as holotype, except collected in forest interior, 1 ♀, 18 September 1984 (T. Werner & T. Sherry, INBio), 1 ♀, 23 September 1984 (T. Werner & T. Sherry, LACM).

Diagnosis.—Adults of *Coelostathma* are characterized by a pale whitish tan ground color with a forewing pattern that usually includes a pair of transverse brown lines or fascia, one in the subterminal region and one across the middle of the forewing, with one or more small, expanded costal patches at the origin of the lines. In *C. insularis* the subterminal line consists of a series of interrupted dashes or dots and is angled rather than curved through the apical region, and the costal patches are extremely reduced. The genitalia of *C. insularis* are most similar to those of *C. binotata* (Walsingham) in the overall shape of the sacculus and valva, and the short uncus in the male, and the subbasal attachment of the ductus to the corpus bursae in the female. Differences in male genitalia between the two are subtle: *C. insularis* has slightly more elongate and attenuate valvae, a shorter uncus (extending only slightly beyond the socius), a more robust and prominent distal termination of the sacculus, and a slightly wider transtilla. In contrast, differences in the female genitalia are striking: in *C. insularis* the portion of the corpus bursae caudad of the attachment with the ductus bursae is uniform rather than narrowed or constricted, and a signum is lacking (all other described species of *Coelostathma* have a well developed, elongate, curved, band-shaped signum).

Most *Coelostathma* have a single mid-dorsal abdominal pit on A2, although these may be variably developed and sometimes difficult to observe in older genitalic preparations. Pits are present on A2 and A3 in *C. parallelana* Walsingham and an undescribed species from Argentina, and absent altogether in an undescribed species from Guatemala and Costa Rica. The single male of *C. insularis* has abdominal pits on A2–A7, the two females on A2.

Distribution and biology.—*Coelostathma insularis* is known only from Cocos Island, Costa Rica. Nothing is known of the biology; consistent with most Sparganothini, the larvae of *Coelostathma* are presumed to be general feeders. See Hogue and Miller

(1981) and Brown et al. (1991) for discussion of biogeography and geologic history of Cocos Island.

Etymology.—The species name refers to the insular distribution of this taxon on Cocos Island.

Remarks.—*Coelostathma* Clemens is restricted to the New World, occurring from southeastern Canada (Quebec, Nova Scotia) south through the eastern United States, Central America and the Caribbean, to South America (Colombia, Ecuador, Peru, Argentina). Powell et al. (1995) assigned five species to the genus: *C. binotata*, *C. contigua* Meyrick (illustrated in Clarke 1958: 90), the type species *C. discopunctana* Clemens, *C. immutabilis* Meyrick (illustrated in Clarke 1958: 90), and *C. parallelana*. Kimball (1965) and Lambert (1950) recognized the presence of an undescribed species in the southeastern United States, and Lambert (1950) recognized four additional undescribed species in the Neotropical Region.

In the original description of *C. binotata*, Walsingham (1914) cited the type series as follows: “Type ♂ (66331); ♀ (66332) Mus. Wlsm. (*Godm-Salv. Coll.*) BM. [PT. (66338–41, 66345) US. Nat. Mus.].” When both sexes were available Walsingham typically designated a type male and a type female. To alleviate any potential ambiguity, we herein designate the male (66331), from Teapa, Tabasco, Mexico, III-1918, H. H. Smith (BMNH), genitalic slide 7821, as the lectotype of *C. binotata*.

In their revision of *Sparganothina*, Landry and Powell (1999) indicate that the genus may be paraphyletic with regard to *Coelostathma*, and that the latter may not be monophyletic as currently defined. Consequently, the generic assignment of *C. insularis* is provisional pending further analyses of the species of *Coelostathma* (but see discussion below).

ABDOMINAL DORSAL PITS

In a few genera scattered throughout the Tortricinae, the dorsum of abdominal seg-

ments 2–7 of the adult moth possesses rounded, shallowly invaginated cavities that have been referred to as dorsal organs (Diakonoff 1955), abdominal organs (Diakonoff 1955, Varley 1956, Obraztsov 1967), dorsal fovea (Zimmerman 1978), or dorsal pits (Horak 1984). Diakonoff (1954, 1955) discovered these structures in *Tremophora* Diakonoff (Archipini); Varley (1956), Obraztsov (1967), and Razowski (1977) reported them in various species of *Archips* Hübner (Archipini); Obraztsov (1967) reported them in *Amorbia* Clemens and *Coelostathma* Clemens, and incorrectly reported their presence in *Platynota* Clemens (Sparganothini); and Zimmerman (1978) reported them in the pupae of *Panaphelix* Walsingham (Archipini) and *Amorbia*. Horak (1984) summarized these findings, adding *Homona* Walker (Archipini). In some of these genera the number and/or presence of pits varies among species, sexes, and even individuals, shedding doubt on their value in phylogenetic inference.

While the function of dorsal pits is unknown, their homology among apparently disparate genera less than certain, and their presence/absence and/or number variable, these structures still may be valuable indicators of relationships, at least at lower taxonomic levels (e.g., Varley 1956). For example, all species of *Orthocomotis* Clarke and the closely related *Paracomotis* Razowski possess two pairs of pits (located subdorsally), one on A2 and the other on A3 (Brown 1989). All species of *Cuproxena* Powell and Brown possess a single pair of pits (located subdorsally) on A2, and all members of the closely related *Bidorpitia* Brown possess two pairs, one on A2 and one on A3 (Brown and Powell 1991). Although it is highly unlikely that the *Orthocomotis*/*Paracomotis* group is closely related to the *Cuproxena*/*Bidorpitia* group, the presence of dorsal pits provides additional evidence for the monophyly of each of these clades. Likewise, Diakonoff (1955) indicated that all species of *Tremophora*

possess similar paired dorsal pits in both sexes.

In Sparganothini dorsal pits are present in one or more species of *Coelostathma*, *Amorbia*, *Aesiocopa* Zeller, and *Sparganopseustis* Powell and Lambert. Dorsal pits are absent in representatives of all other sparganothine genera we examined (i.e., *Platynota* Clemens, *Niasoma* Busck, *Synalocha* Powell, *Syllonomma* Powell, *Synnoma* Walsingham, *Sparganothis* Hübner, *Paramorbia* Powell and Lambert, *Lambertiodes* Diakonoff, *Sparganothoides* Lambert and Powell, and *Sparganothina* Powell). In *Coelostathma*, *Amorbia*, and *Aesiocopa*, the pits are single, medial, rounded depressions located at the anterior portion of the abdominal segment, and are present in both sexes. In some specimens the pit(s) appears slightly bilobed, suggesting that it represents the fusion of a pair of adjacent subdorsal pits. When present in *Sparganopseustis* (ca. 50% of species), abdominal pits are paired, subdorsal in position, and conspicuously more developed in males than in females, frequently with modified scaling and/or microtrichia (S. Cho, unpublished). The position and unusual modifications of the pits in *Sparganopseustis* suggest that they may not be homologous with those of other sparganothine genera.

In all North American and many Neotropical *Amorbia* there is a single dorsal pit on A3 (or A2) in both sexes, sometimes with a faint indication of additional pits on A4–A7. In at least some Neotropical species with highly modified labial palpi (e.g., *A. rectilineana* (Zeller)) and/or a large costal fold (e.g., *A. productana* (Walker)), characters which deviate from *Amorbia adumbrana* (the type species) and related species, the pits are absent or inconspicuous. The concordance of these few characters suggests that the presence of dorsal pits may either help define a monophyletic group within *Amorbia* or exclude from the genus those species that lack pits. Alternatively, the pits may have been lost secondarily in the more divergent species.

Although present in nearly all *Coelostathma*, dorsal pits are absent in *Sparganothina*, the putative sister genus (Landry and Powell 1999). As in the examples cited above, dorsal pits may provide convincing evidence for the assignment of species to genera, but may provide no evidence of relationships between or among genera, i.e., the presence of these structures may support the monophyly of *Coelostathma* but provides no evidence of its relationship to *Sparganothina*.

While the presence of dorsal pits in Sparganothini, Archipini, and Euliini may not clarify our knowledge of phylogenetic relationships among these and other tortricine tribes, the structures may prove valuable for assessing relationships within genera and distinguishing between closely related genera. Further investigations into the large array of undescribed Sparganothini may shed additional light (or doubt) on the value of these structures in defining phylogenetic relationships within that tribe.

ACKNOWLEDGMENTS

We thank the late Charles Hogue (LACM), the late Robert Silberglied (MCZ), Paul Arnaud (CAS), Jerry Powell (UCB), Ronald Hodges (USNM), Kevin Tuck (BMNH), and Eugenie Philips (IN-Bio) for allowing us to examine material in their care. We thank K. Tuck for information regarding dorsal pits of *Coelostathma* in the collection of The Natural History Museum. We thank J. Powell for making available his personal notes on the distribution of dorsal pits in the Sparganothini and Lambert's unpublished thesis, and Soowon Cho for discussions regarding the presence of pits in *Sparganopseustis*. The photograph of the adult was provided by Victor Krantz, National Museum of Natural History, Smithsonian Institution, Washington, D.C., and those of the male and female genitalia by David Preston, Bishop Museum. We are grateful to the following for reviewing and providing helpful comments on various drafts of the manuscript: Jerry Powell,

University of California, Berkeley, California; Alex Konstantinov, USDA, Systematic Entomology Laboratory, National Museum of Natural History, Washington, D.C.; Richard Brown, Mississippi State University, Mississippi State, Mississippi; and William Miller, University of Minnesota, St. Paul, Minnesota. Scott Miller's research was supported in part by a Smithsonian Visiting Research Appointment and an American Philosophical Society Grant (Penrose Fund). Curation of much of the Cocos Island material was supported by National Science Foundation grant BSR8800344 to LACM.

LITERATURE CITED

- Brown, J. W. 1989. New tribal assignment for *Orthocomotis* Dognin and *Paracomotis* Razowski based on an unusual modification of the chaetosema (Lepidoptera: Tortricidae). *Pan-Pacific Entomologist* 65: 454–457.
- Brown, J. W. 1991. Sphingidae (Lepidoptera) of Isla de Coco, Costa Rica, with remarks on the macrolepidoptera fauna. *Brenesia* 33: 81–84.
- Brown, J. W., J. P. Donahue, and S. E. Miller. 1991. Two new species of geometrid moths (Lepidoptera: Geometridae: Ennominae) from Cocos Island, Costa Rica. *Natural History Museum of Los Angeles County, Contributions in Science* 423: 11–18.
- Brown, J. W. and J. A. Powell. 1991. Systematics of the *Chrysoxena* group of genera (Lepidoptera: Tortricidae: Euliini). *University of California Publications in Entomology* 111. 87 pp.
- Clarke, J. F. G. 1958. Catalogue of the type specimens of microlepidoptera in the British Museum (Natural History) described by Edward Meyrick, Vol. 3. Trustees of the British Museum, London. 600 pp.
- Diakonoff, A. 1954. Microlepidoptera of New Guinea. Results of the Third Archbold Expedition (American-Netherlands Indian Expedition 1938–1939), Part 3. *Verhandelungen Koninkl. Nederlund Akademie van Wetenschappen, Afd. Natuukunde, series 2*, 49: 1–164.
- Diakonoff, A. 1955. A note on a peculiar abdominal organ in certain Tortricidae (Lepidoptera). *Transactions of the Royal Entomological Society of London* 107: 199–202.
- Hogue, C. L. and S. E. Miller. 1981. The entomofauna of Cocos Island, Costa Rica. *Atoll Research Bulletin* 250: 1–25.
- Horak, M. 1984. Assessment of taxonomically significant structures in Tortricinae (Lep., Tortricidae).

- Bulletin de la Société Entomologique Suisse 57: 3–64.
- Kimball, C. P. 1965. Arthropods of Florida and neighboring land areas, Vol. 1. Lepidoptera of Florida. State of Florida, Department of Agriculture, Gainesville.
- Lambert, R. L. 1950. Revision of the moths of the subfamily Sparganothidinae (Lepidoptera: Tortricidae). Ph.D. Thesis, Cornell University, Ithaca, New York.
- Landry, B. & J. Powell. 1999. Systematics and phylogeny of *Sparganothina* (Lepidoptera: Tortricidae: Sparganothini). University of California Publications in Entomology (In press).
- Obratzov, N. 1967. Some considerations about an abdominal organ in certain tortricine moths. Lepidopterists' News 10: 153–156.
- Powell, J. A., J. Razowski, and J. W. Brown. 1995. Tortricidae: Tortricinae, pp. 138–150 In Heppner, J. B., ed., Atlas of Neotropical Lepidoptera, Checklist: part 2, Hyblaeoidea-Pyraloidea-Tortricoidea. Association for Tropical Lepidoptera, Gainesville, Florida.
- Razowski, J. 1977. Monograph of the genus *Archips* Hübner (Lepidoptera, Tortricidae). Acta Zoologica Cracoviensia 22: 55–205.
- Varley, G. C. 1956. Dorsal abdominal organs in certain Tortricidae (Lep.). Entomologists' Monthly Magazine 92: 107–108.
- Walsingham, Lord T. de Grey. 1914. Biologia Centrali-Americana. Insecta, Lepidoptera Heterocera, Vol. 6. British Museum (Natural History), London.
- Zimmerman, E. C. 1978. Insects of Hawaii, Vol. 9. Microlepidoptera. Part 1. The University Press of Hawaii, Honolulu. 881 pp.